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Effect of organics and IPM on yield attributes, fruit yield and disease incidence in chilli in Sagar district of Madhya Pradesh

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Abstract
A study was conducted to evaluate the economic viability of organic cultivation and integrated pest management technology in chilli in Sagar district under Bundelkhand region of Madhya Pradesh during 2016-17 to 2018-19 in participatory mode at farmers' fields. Among the organic nutrient sources, basal application of FYM @ 10tonne, vermicompost @ 2.5 tonne and Neem G @ 100 kg ha^{-1} was done with enrichment of biofertilizers (Azotobactor & PSB) and *Trichoderma viride* @ 5 kg ha^{-1}.'Naturamore Gold' an organic product applied @ 25 kg ha^{-1} in standing crop for nitrogen supplement. For integrated pest and disease management insect attractants, biopesticides and neem-based formulations were used. The study findings indicated that the green yield of chilli was 34.2 percent higher in the crop cultivated using organic sources (8.75 tha^{-1}) in comparison to farmers practice (6.52 tha^{-1}). Among the diseases, average incidence of wilt was noted 2.75 percent in the technological interventions against 6.75 percent in farmer's practice, however anthracnose disease in the study fields was quite less (1.25%) during study period. Pod borer and sucking pest incidence recorded 0.17 larvae $plant^{-1}$and 7.5 $plant^{-1}$ respectively under organic chilli production over FP (0.56 larvae $plant^{-1}$ and 15.25 $plant^{-1}$). Organic production of chilli contributed increased net return of Rs. 1, 54, 025 ha^{-1} and benefit cost (B:C) ratio (3.38) over farmer's practices where these were recorded Rs.78,375ha^{-1} and 2.51 respectively.

Keywords: Biology, Chilli, organic sources, integrated pest management, biopesticides, net return, B:C ratio

Introduction
Chilli, *Capsicum annuum* L., is one of the major vegetables commercially cultivated as condiment, is essential for all Indian dishes. Today India has emerged as the foremost producer and consumer of chilli contributing to almost 38 percent of the world production. Chilli is largely grown for its green fruits and commercially for dry chilli as spice. Its green fruits are the rich source of vitamin C, A and B. In India it is cultivated as cash crop both for domestic and export market. Globally it is cultivated in about 20.20 million hectares with the production of 37.62 million tones annually. India is the largest producer of in the world with 13.76 million tonnes of chilli production annually followed by China which produces around 3 million tones. Out of the total chilli production in world (37.62 million tonnes), India contributes36.57 percent followed by China (7.97 percent). India also ranks first in the area covered under chilli cultivation (Geetha and Selvarani, 2017) [3]. Many fungal, bacterial and viral diseases considerably affect the crop resulting in immense yield losses. Dry root rot caused by *Sclerotium rolfsii* in chilliis the major fungal disease triggering the economic losses in chilli in recent years (Kalmesh and Gurjar 2001) [5]. Concomitantly, agricultural production continues to be inhibited by numerous biotic and abiotic factors i.e. insect pests, diseases and weeds which causesizable damage to potential agricultural production. Chilli thrips (*Scirtothrips dorsalis*) is one of the vital restrictive factors in production. Thrips adults and nymphs penetrate and suck the tender leaves sap, developing shoots, emerging flowers and create distinctive leaf curl symptoms. Due to the above, economic yield loss might be 11 to 32 percent quantitatively and 88 percent qualitatively in chilli (Mandal 2012) [6]. Due to their soft and elastic nature, vegetables are most susceptible to pest infestation and at a conservative estimate cause around 20–25 percent losses. Root rot of chilli caused by *S. rolfsii* was reported first time in Jaipur (Rajasthan) chilli growing areas, where the sever mortality of chilli plants was observed during the month of March-April (Kalmesh and Gurjar 2001) [5].

Intensive cultivation of chilli with poor crop management and faulty crop rotation, has led to nutrient imbalance, increase in diseases and pests' occurrence bring about 50-60 percent yield loss. Among the various diseases; damping off in nursery stage, leaf curl and anthracnose are leading constraints in chilli production and causes reasonable yield losses. There are ample possibilities to increase chilli production using improved production practices, soil test based nutrient management and appropriate and timely plant protection practices. Integrated crop management practices resulted improved production with insect pest and disease management.

Technology demonstration is a systematic approach to illustrate how a technology works, how to conduct, principles involved in an operation and to demonstrate the end results of the technology/practice adopted. The present study was therefore conducted in participatory mode at farmer's field during 2016-17, 2017-18 and 2018-19 in Sagar district to assess the impact of organics, attractants, biopesticides and neem based formulations in chilli.

Materials and Methods

To evaluate the economic viability of organic cultivation and IPM technology in chilli, the technology demonstrations were conducted at farmer's field of in Chitora, Patan and Semrabagh villages of Sagar district of Bundelkhand region in Madhya Pradesh during 2016-17 to 2018-19 in medium fertility status soils. Each demonstration was laid on an area of 0.50 ha and the same area adjacent to it was kept as farmer's practices (FP) as per the demonstration principles suggested by Das *et.al*. (1998) [2]. The package of technology demonstration included improved variety 'Aruna' in 2016-17 and VNR 145 in 2017-18 and 2018-19.To fulfill the nutrient requirement (NPK80:60:40 kg ha^{-1}) FYM @ 10tonne, vermicompost @ 2.5 tonne and Neem G (neem formulation) @ 100 kg ha^{-1} was applied as basal with biofertilizers (Azotobactor and PSB @ 5 kg ha^{-1}) and *Trichoderma viride* @ 5 kg ha^{-1}.Seeds were treated with *Trichoderma viride* @ 10 g kg^{-1} was used for seed treatment to prevent the seed-borne diseases and inoculated with azotobactor and PSB @ 10 g kg^{-1} seed for increasing availability and efficacy of nitrogen and phosphorus in root zone. Seed sowing was done in raised bed nursery on03 March 2017, planted in the main field during 5-8 April 2017 and fruit picking started from 25 May 2017 during first year. An organic product 'Naturamore Gold' powder applied @ 25 kg ha^{-1} in standing crop for nitrogen supplement. In second and third year, nursery was laid in the second week of October and transplanting was done in the first week of November. Fruit picking started from 20 December and 18-20 pickingswere taken during the crop period. For effective control of weed sone hand weeding was done at 25 DAT. Yellow and blue sticky traps @ 50 Nos ha^{-1} and pheromon traps (20 Nos ha^{-1}.) were installed for observation and management of sucking pests and pod borer. Foliar spray of biopesticides viz. Neem beam (1500 ppm), Lastraw (1 Lha^{-1}), Super Parasmani (1L ha^{-1}) and Onset (1 L ha^{-1}) were applied at 10 days interval for management of insects-pests.

The data on germination, plant height, number of branches$plant^{-1}$, number of fruits $plant^{-1}$,green chilli yield, wilt, anthracnose disease incidence, infestation of sucking pests and pod borer were recorded from growth to crop harvest stage. The cultivation cost, gross, net monetary return and benefit cost (B: C) ratio was calculated based on existing market price. In addition, the above data on was also recorded from the equal area under local check (farmer practices) adjacent to the technology demonstrations. The benefit cost (B: C) ratio was calculated based on gross return. The following formulae were used to calculate the parameters-

Increase in fruit yield= yield of demo plot–yield of FP plot / yield of FP plot *100
Net Return= Gross Return – Cost of Cultivation
Benefit Cost Ratio= Gross Return / Cost of Cultivation*100
Yield gap = Potential yield – Demonstration yield.

Results and Discussion

Effect on yield attributes and fruit yield

Application of nutrients through organic sources and IPM practices enhanced the chilli production under technology demonstration plots. The pooled data on number of branches per plant under organic production noted to be 23against the farmer's practice (16.75 per plant) during the study period. The number of fruits $plant^{-1}$wereincreased and recorded to be 367.75 in organic production technology as compared to that of farmers practice (280). Yield of chilli with respect to green fruits was found 34.2 per greater in organic technology demonstrations (8.75 tha^{-1}) in comparison to FP plots (6.52 t ha^{-1}). Singh *et al*. (1997) noticed that the use of vermicompost enhanced the microbial activities and thus it has positive impact in terms of higher number of branches and fruits in chilli. Potato tuber treatment with Azotobacter and PSB consortia @ 20 g/kg and its soil inoculation with FYM @ 15 t ha^{-1} resulted 9.2 tubers $plant^{-1}$, 246.23 g fresh tuber $plant^{-1}$, tuber girth of 4.6 cm and total tuber yield of 24.41 t ha^{-1} (Raj *et al.* 2019) [9].

Effect on Disease incidence

The occurrence of wilt disease in the technology demonstrationswas6, 3 and1 percent however, in FP plots it was 12,8and 4 percent during the years 2016-17to 2018-19 respectively. The average wilt incidence was 2.75 percent in technology demonstrations over FP plots where it was6.75 percent. It may be due to *Trichoderma viride* enrichment with FYM which effectively controlled the disease pathogens under demonstrated technology. Similar findings also noted by Bindu and Bhattiprolu (2001) [1]. These findings are supported by Singh (2007) [11] who also reported moderate effect of *T. viride* and *T. harzianum* against chilli wilt in Himachal Pradesh. The incidence of anthracnose disease was quite less during study period. The average incidence was 1.25 in the demonstration plots against local check (farmers practice) where it was 3.25 percent. This may be due to appropriate management through consistent spray of neem-based formulations and other bio pesticides.

Effect on insect pest infestation

The spray of biopesticides (Neem beam, Lastraw, Super Parasmani, Onset) and installation of yellow, blue sticky traps and Pheromone traps which restricted the pod borer and sucking pests i.e. white fly, thrips population which eventually checked the leaf curl disease incidence in the crop. Average reduction in pod borer incidence found from 0.56 to 0.17 larvae $plant^{-1}$ while incidence of sucking pest reduced from 15.25 to 7.5 $plant^{-1}$. Present observations are in close conformity with those of Sharma *et al*. (2012) [10] who opined neem oil 3 percent has high repellency activity against *S. litura*. Sinha (1993) [13] reported that spray of neem kernel

extracts (38.57%) and neem oil (5%) were found effective in managing the populations of *H. armigera*.

Economic analysis

The economic feasibility of organic cultivation of chilli over farmer's practices was find out considering the prevailing prices of inputs and outputs. Various variables i.e. seed, manures, fertilizers (organic, inorganic and bio-fertilizers) and pesticides were identified as cash inputs for technology demonstrations as well as in local check (farmer's practice). The average cost of chilli cultivation by organics was Rs. 64600 ha^{-1} however, in local check (farmers practice) it was Rs. 52125 ha^{-1}.An additional cost Rs.12475 ha^{-1} higher the average net return of Rs.75650ha^{-1} in the organic production system. The increased cultivation cost under technology demonstrations was largely due to the cost of organic manures used for sensible nutrient application which can be minimized in subsequent years due to soil carbon and microbial biomass build up; and conservation of nutrients within the root zone. Cultivation of chilli under organic demonstrations resulted higher net return (Rs. 1,54,025 ha^{-1}) over farmer's practices where it was noted to be Rs. 78,375 ha^{-1}. Use of organic Chilli production also resulted greater benefit cost ratio of 3.38 in comparison to 2.51 under local check (farmers practice). These results are consistent with those of Hiremath and Nagaraju (2009) [4], who published comparable findings. The findings of the present study clearly point to the potential of organic production technologies for chilli farming that can be duplicated in Madhya Pradesh's chilli growing regions and other regions of the nation with comparable agro climatic conditions.

Table 1: Effect of nutrient management through organic sources and IPM on yield attributes and fruits yield of chilli.

Year	Plant height (cm)		Number of branchesplant^{-1}		Number of fruits plant^{-1}		Yield (tha^{-1})	
	FP	Demo	FP	Demo	FP	Demo	FP	Demo
2016-17	2.10	2.24	16	21	288	342	6.5	8.4
2017-18	2.20	2.51	18	24	264	388	6.2	8.1
2018-19	2.12	2.45	17	22	278	346	6.6	9.3
Mean	2.10	2.42	16.75	23	280	367.75	6.52	8.75

Table 2: Effect of nutrient management through organic sources and IPM on disease and insect incidence in chilli.

Year	Wilt incidence (%)		Anthracnose Disease (%)		Pod borer (Larvaeplant^{-1})		sucking pest (Number plant^{-1})	
	FP	Demo	FP	Demo	FP	Demo	FP	Demo
2016-17	12	6	4	2	0.8	0.1	18	11
2017-18	8	3	2	0	0.4	0.2	12	7
2018-19	4	1	5	2	0.5	0	17	8
Mean	6.75	2.75	3.25	1.25	0.56	0.17	15.25	7.5

Table 3: Economics of chilli under technology demonstrations using organic sources and IPM.

Year	Cost of cultivation (Rsha^{-1})		Gross Return (Rsha^{-1})		Net Return (Rsha^{-1})		Benefit Cost ratio	
	FP	Demo	FP	Demo	FP	Demo	FP	Demo
2016-17	51500	64800	130000	210000	78500	145200	2.52	3.24
2017-18	54200	62600	124000	202000	69800	139400	2.29	3.23
2018-19	54300	66500	132000	232500	77700	166000	2.43	3.49
Mean	52125	64600	130500	218625	78375	154025	2.51	3.38

Conclusions

The organic technological interventions on chilli resulted higher fruit yield with significant reduction in diseases and pests. The increase in additional net return under technological interventions was noted six times higher with an additional cost of Rs. 12475 ha^{-1} which may be afforded even by the small and marginal farmers looking the significant increase in net return. Due to use of organic sources, quality chilli fruits obtained and sold at higher rates which ultimately resulted higher net return.

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